Remarks
ON
GENERAL SPINAL ANALGESIA.

BY
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AT a meeting of the German Society of Surgery in Berlin in April, 1909, Professor Bier of Berlin is reported[1] to have said that the method of general spinal analgesia described by me at the Congress of the International Society of Surgery in Brussels in September, 1908, must be rejected, and Professor Rehn of Frankfort is reported[1] to have said that experiments on animals showed that considerable danger attended such injections if made higher than the lumbar region as recommended by me.

These pronouncements, which seem to be without appeal, prove once more that the method described by myself and my assistant, Dr. Amza Jiano, was too novel and too hardy to be accepted without opposition. I have never doubted that this would be so, but the facts which I am about to state will prove the conviction that this condemnation on *a priori* grounds is mistaken, and I am firmly convinced that my new method of general spinal analgesia will in a short time be universally accepted. During the eight months subsequent to October, 1908, I used spinal analgesia in all my operations, whether performed in the university clinic, in the Coltza Hospital, or in my private practice; I have never once had recourse to anaesthesia by inhalation. In addition, my hospital colleagues have daily had recourse to this method with complete success. Dr. Canny Ryall, of London, who spent twenty days in Bucarest for the purpose of studying my method, saw it used for forty operations of various character, and afterwards used it in the clinics of Professor Doelinger, of Budapest, and Eiselsberg, of Vienna. Recently I practised it myself in the clinic of Professor Schauta, of Vienna, who was convinced of its superiority over anaesthesia by inhalation. The description of the actual method which I shall now give is founded upon this extensive experience of its use.

METHOD.

There are two essential points of novelty in the method: (1) The puncture is made at a level of the spinal column appropriate to the region to be operated upon; (2) an anaesthetic solution is used which, thanks to the addition of strychnine, is tolerated by the higher nervous centres. The selection of the anaesthetic substance to be used will be determined by the surgeon's experience or confidence in any particular drug. I prefer stovaine, which has given me excellent results, and which I know how to manage; but tropacocaine or novocain are equally efficacious, and, thanks to the addition of strychnine, equally harmless.

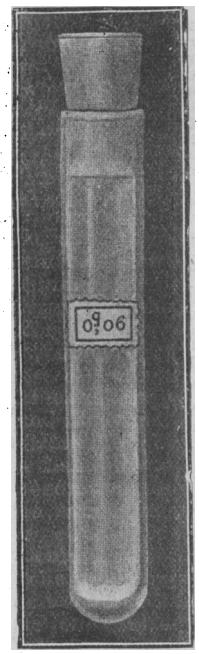

Fig. 1.

1. *The Preparation of the Solution.*

The solution must be made at the time when the operation is to be performed as follows: The necessary quantity of stovaine, tropacocaine, or novocain is introduced into a glass tube (Fig. 1) provided with an indiarubber stopper, and sterilized in the autoclave. The substances need not be sterilized since they are themselves antiseptic, and some of their properties would be destroyed by heat.

The strychnine solution is made by dissolving 5 to 10 cg. of neutral strychnine sulphate in 100 grams of sterilized (not distilled) water in a glass-stoppered bottle previously sterilized; if 5 cg. of strychnine are used, 1 c.cm. of the solution will contain ½ mg.; if 10 cg., 1 c.cm. will contain 1 mg. The weaker solution is used for the upper, the stronger for the lower puncture. As the strychnine takes some time to dissolve, it is better to prepare this solution a little before the time when it has to be used. With an ordinary Pravaz syringe provided with a needle for lumbar puncture, 1 c.cm. of the solution of strychnine, a syringeful, is drawn up and is injected into the tube containing the dose of stovaine judged to be necessary for the puncture about to be made. The tube is corked again, and shaken, and the salts are dissolved. The same syringe is then filled with the contents of the tube, and is held with a sterilized compress and removed from the needle while the puncture is being made.

2. *The Apparatus.*

This, as has already been indicated, is very simple, and within the reach of every surgeon in all circumstances, since it consists only of a common Pravaz syringe holding 1 c.cm., and the usual needle for lumbar puncture previously sterilized by boiling. The needle I prefer has a point cut rather squarely, for since the arachnoid space is relatively small, if the point of the needle be oblique, it is possible that part of the opening might go through the dura mater while part remained outside it. If this occurs part only of the solution penetrates into the arachnoid space, while a greater or less quantity is injected into the space between the dura mater and the osseous canal, and either analgesia is not produced at all, or it is incomplete; a result too often attributed to the insufficiency of the method or the idiosyncrasy of the patient.

3. *The Puncture.*

In my communications to the Congress at Brussels and to the Academy of Medicine in Paris, I indicated four points in the spine at which the puncture should be made in order to obtain analgesia of the region to be operated upon. I had already been convinced by experience that spinal anaesthesia was not so regional as I had believed, and that medio-cervical puncture was as useless as it was dangerous. It favours the appearance of bulbar phenomena—nausea, vomiting, pallor of the face, faintness, momentary stoppage of respiration, and so on, phenomena due to a too direct action of the anaesthetic fluid upon the bulb. Their occurrence may be avoided by making the puncture lower down between the first and second dorsal vertebrae, which produces as perfect and deep analgesia for the segment of the body comprising the head, neck, and upper limbs as is produced by medio-cervical puncture. Medio-dorsal puncture between the seventh and eighth dorsal vertebrae is very often difficult to perform, and is not necessary, for perfect analgesia of the lower segment of the thorax can be obtained by puncture made between the last dorsal and first lumbar vertebrae, which is easier to perform and produces also anaesthesia of the whole lower part of the body.

I have therefore reduced sites of election for puncture to two—namely:

(*a*) *Upper Dorsal Puncture.*

Upper dorsal puncture between the first and second dorsal vertebrae is easily performed; the landmark is the vertebra prominens with the visible and tangible protuberances of the spinous processes of the second and third dorsal vertebrae. When the patient's head is strongly flexed, so that the chin touches the sternum, the protuberances are very marked, and the spaces they bound are enlarged (Figs. 2, 3, and 4). The patient being placed in this position, the surgeon marks with the forefinger of his left hand the space between the first and second dorsal vertebrae, and the needle, held between the thumb and forefinger and middle finger of the right hand, is pushed in, following the upper border of the spinous processes of the second dorsal vertebrae (Fig. 4). For operations on the head, neck, upper limbs, and thorax the puncture should be made in this situation.

(*b*) *The Dorso-Lumbar Puncture.*

The dorso-lumbar puncture between the twelfth dorsal and first lumbar vertebrae is very easily made, owing to the large space which separates the two spinous processes. (Figs. 2 and 3). I prefer this puncture to the classical lumbar puncture between the third and fourth lumbar

vertebrae, because it produces more perfect analgesia of the whole abdomen and lower segment of the body. The space is easily found, for it is necessary only to count the lumbar spines upwards. The patient is seated with the thorax bent strongly forward, as in ordinary lumbar puncture (Fig. 5). In making the puncture, the forefinger of the left hand marks the space, while the needle is pushed in with the right hand, following the upper border of the underlying spinous process.

In both cases the puncture is made in the median plane. Once the resistance of the skin has been surmounted, the needle must be pushed forward slowly, so as not to tear the tissues which are being transfixed. As a rule the needle enters easily as far as the dura mater, when a momentary resistance is felt; when this has been overcome, the flow of spinal fluid shows that the needle is in the right space. When the puncture is made at the high dorsal level, where the pressure of the cerebro-spinal fluid is diminished, it comes out drop by drop, whereas in the dorso-lumbar puncture it spurts out in a stream. This is the rule, but there are exceptions, for sometimes in the high dorsal puncture no fluid escapes; an effort of coughing will then usually suffice to make it appear, although it may be necessary to adapt a sterilized syringe to the needle in order to aspirate the fluid. If no fluid is thus obtained, the surgeon must conclude that his needle is not in the arachnoid cavity; the point of the needle must be disengaged, drawn back slightly, and pushed in again until the space is found. If the needle is introduced obliquely it may impinge on a lamina, but the peculiar sensation of having touched bone will warn the surgeon; he must then withdraw the needle completely and reintroduce it in the proper way — namely, in the median plane. If the fluid which escapes is blood-stained, it shows that a small vein has been transfixed—a matter of no importance, since the haemorrhage will soon cease spontaneously and the fluid become clear.

It is also possible to make the punctures with the patient lying on his right side, the head being strongly bent on the chest for the high dorsal puncture, and the thorax being bent forward for the dorso-lumbar puncture. This position should be preferred when the patient is feeble or very impressionable and cannot remain in the sitting position without risk of fainting; it must also be used if, an operation having lasted longer than was anticipated, a second puncture and injection to prolong the analgesia become necessary.

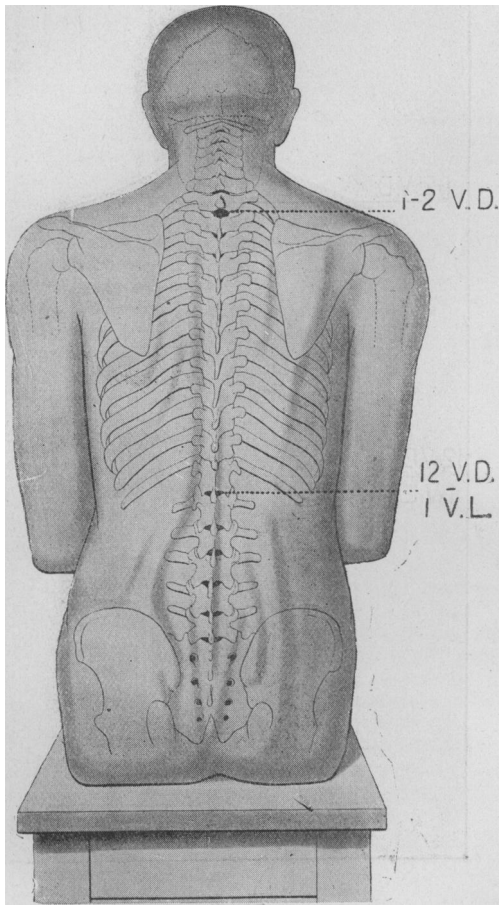

Fig. 2.

4. *The Injection.*

As soon as the escape of cerebro-spinal fluid renders it certain that the arachnoid space has been entered, its further loss should be stopped, for I am convinced that the escape of more than a certain quantity of fluid is rather harmful than useful. The loss of too much fluid (1) may cause signs of faintness, pallor of the face, sweating, etc.; and (2) by suddenly diminishing the quantity of cerebro-spinal fluid may cause too rapid diffusion of the anaesthetic, which is undesirable and may be mischievous. As soon, then, as a few drops of fluid have escaped, the needle is closed with the forefinger of the left hand, while with the right the syringe filled with the anaesthetic mixture is adapted to the needle. The liquid must be slowly injected so as not to produce an undue impact upon the spinal cord.

5. *Position of Patient after Injection.*

The position to be assumed by the patient after the injection, so as to ensure analgesia of the region to be operated upon, is a cardinal point, for by attention to it we can favour the distribution of the liquid in the desired direction. If with the higher dorsal injection it is desired to obtain analgesia of the head and neck, the patient is made to lie on his back; if the operation is to be on the throat, the head should be a little raised; if on the face or skull, he should lie horizontally; if on the upper limb or the thorax, he should remain sitting for two or three minutes, and then lie on the back with the head, neck, and thorax bent slightly forward. If after four or five minutes the analgesia of the head or of the neck is not complete, the patient's head should be lowered below the level of the body for three or four minutes.

With dorso-lumbar injection if the viscera of the upper abdominal region (liver, stomach, spleen, pancreas, kidneys, etc.) are to be operated upon, the patient must remain in the sitting posture for two or three minutes, and then lie on the back, the head neck, and shoulders being raised. If after five or six minutes the analgesia is incomplete, the patient must be inclined (Trendelenburg) for a few minutes three or four, after which he again returns to the sitting posture. If the operation is on the lower abdominal region (pelvis, perineum, external genital organs) or on the lower limbs, the patient should remain in the sitting posture for five or six minutes, and then lie on his back, with the upper part of the body, head, neck, and thorax raised and bent forward.

6. *The Dose.*

The amount of stovaine and strychnine in the anaesthetic mixture should vary with the site of the injection, the patient's age, and his general condition. I confine my remarks to stovaine, as it is the drug with which long practice has made me familiar, so that I can administer it with precision and safety. I cannot speak with equal confidence of other anaesthetics, such as novocain and tropacocaine, with which I have had little experience.

(1). *Strychnine.*

The variation in the quantity of strychnine is not relatively great. For the higher dorsal injection I employ: For children of from 1 to 5 years $\frac{1}{3}$ mg. in 1 c.cm. The solution is made by dissolving $3\frac{1}{2}$ cg. of neutral strychnine sulphate in 100 grams of sterilized water. For children above 5 years, for adolescents, adults, and aged people the solution contains $\frac{1}{2}$ mg. of neutral strychnine sulphate in 1 c.cm., and is made by dissolving 5 cg. of the strychnine salt in 100 grams of sterilized water. For dorso-lumbar injection, for children from 1 to 10 years old, I use a solution containing 1 mg. of strychnine in 1 c.cm.; for children above 10 years, adolescents, adults, and old people, a solution containing 1 mg. in 1 c.cm., made by dissolving 10 cg. of the neutral strychnine sulphate in 100 grams of sterilized water.

(2). *Stovaine.*

The amount of stovaine varies with the site of the injection, the patient's age, and his general condition. For the higher dorsal injection I use for children from 1 to 5 years old, 1 cg.; from 5 to 15 years, 2 cg.; for adolescents, adults, and aged people, 3 cg. For the dorso-lumbar puncture, for children from 1 to 5 years, 2 to 3 cg.; from

5 to 15 years. 4 to 6 cg.; for adolescents from 15 to 20 years old, 6 to 8 cg.; and for adults and aged people 10 cg. The dose of stovaine must also be adapted to the general condition of the patient. In persons who are consumptive, very anaemic, who are suffering from autointoxication or grave infections, or who have suffered severe injury, or are ischaemic owing to profuse haemorrhage, 5 or 6 cg. of stovaine produce deep and prolonged analgesia, and larger doses are badly tolerated, causing pallor of the face, nausea, vomiting, and transient faintness.

In order to be able to judge of the degree of the diffusibility of the liquid injected into the arachnoid cavity the specific gravity of the solution of strychnine and stovaine compared with that of the cerebro-spinal fluid must be known. The average density of cerebro-spinal fluid is 1,003, but it varies from 1,003 to 1,020.[2] Dr. Hancu, Chief Pharmacist to the Coltza Hospital, has found that the following solutions have the specific gravity stated:

	Grams.	Sp. gr.
1. Strychnine	0.05	
Stovaine ...	2.00	... 1,0019
Water ...	100.00	
2. Strychnine	0 05	
Stovaine ...	3.00	.. 1,0030
Water ...	100.00	
3. Strychnine	0.10	
Stovaine ...	6.00	... 1,0071
Water ...	100.00	
4. Strychnine	0.10	
Stovaine ...	8.00	... 1,0105
Water ...	100.00	
5. Strychnine	0.10	
Stovaine ...	10.00	... 1,0120
Water ...	100.00	

The solution used for injection in high dorsal puncture (containing 3 cg. of stovaine and ½ mg. of strychnine) has a specific gravity equal to or greater than the average density of cerebro-spinal fluid; this fact explains the rapid diffusion towards the cervical part of the cord and the cranial cavity, which, as will be shown later, takes place if the injection is made here, and also the readiness with which analgesia is produced. The solution used for injection in the dorso-lumbar puncture has, on the other hand, a specific gravity greater than that of cerebro-spinal fluid, and the larger the quantity of stovaine the higher the specific gravity. In this situation the diffusion of the solution takes place slowly, a fact which explains the relative delay in the production of the analgesia, and partly also the harmlessness of the Trendelenburg position, the solution tending to remain in the lower parts of the arachnoid cavity.

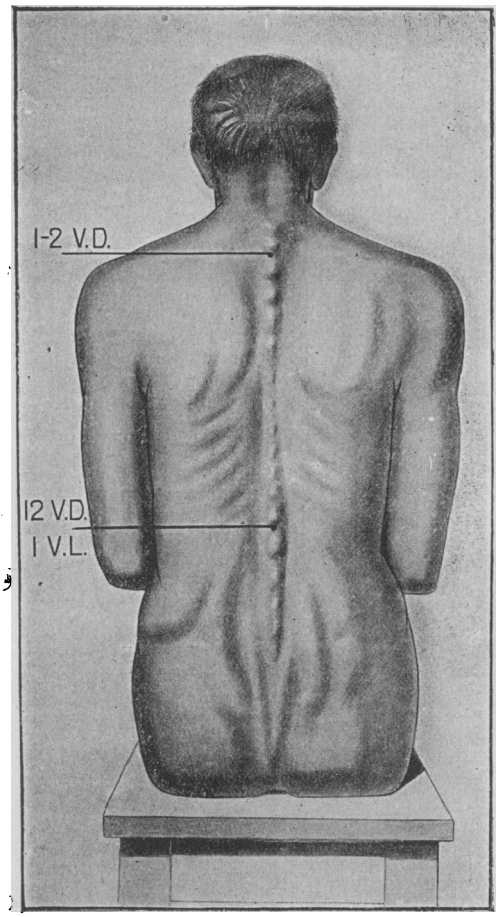

Fig. 3.

PHENOMENA OBSERVED DURING ANALGESIA.

With the higher dorsal puncture the analgesia is, for the reason just stated, usually complete in two or three minutes. On the other hand, after dorso-lumbar injection, analgesia is produced more slowly, but is complete in at most ten minutes. If analgesia is not obtained within this time, it is evidence that the solution has not reached the arachnoid cavity, or has reached it in too small a quantity, and the puncture and injection must be repeated. It is a mistake to attribute failure to produce analgesia to idiosyncrasy. It is true that I have seen some cases in which after puncture followed by a flow of cerebro-spinal fluid no analgesia has been produced, but a second, or in some cases a third injection of the same dose of the anaesthetic has produced complete analgesia. It is tempting to suppose that these patients were refractory to normal doses and required larger doses, but this is a mistake; no patient could support 20 to 30 cg. of stovaine and 2 or 3 mg. of strychnine without presenting marked bulbar phenomena—stoppage of breathing and of the heart—attributable to the excess of stovaine. The occurrence must be otherwise explained. It is to be attributed to an untimely movement of the patient at the moment of the injection, very trifling, perhaps, in appearance, but sufficient to displace the point of the needle already engaged in the arachnoid cavity. Owing to the slight and imperceptible displacement the orifice of the needle is withdrawn partly or wholly from the cavity, and the solution is therefore injected in part or in whole outside the cavity, between the dura mater and the osseous canal.

In one case of high dorsal puncture I only obtained analgesia after a third injection—that is to say, after using 9 cg. of stovaine and 1½ mg. of strychnine, doses which no patient could support without showing bulbar phenomena. It is certain, therefore, that only the third injection penetrated the arachnoid cavity. In another case of dorso-lumbar injection, in a patient in whom on a previous occasion excellent analgesia was obtained with 6 cg. of stovaine, 16 cg. in two injections failed to give any result, and it was only after a third injection of 6 cg. that analgesia was produced.

During analgesia patients retain full consciousness, and I am in the habit of speaking to them to divert their attention from the operation, of which the majority are unaware, the operating field being hidden from them by a cloth supported by two bars attached to the operating table at the level of the neck. I prefer this cloth to a mask, which is embarrassing to the patient and a great trial to his patience during a long operation. A patient may be heard to ask after an operation is finished when it is to be begun.

The immobility of the limbs, the neck, and the head, due to paresis caused by the spinal analgesia, is a great advantage to the surgeon by suppressing movements which might embarrass him. It is true that there may be complete anaesthesia without loss of mobility in the limbs; this rarely happens, but its occurrence ought to be known, as it is not necessary to wait for paresis before beginning to operate.

After dorso-lumbar injection the abdominal viscera, including the intestines, are immobile, and this "abdominal stillness" is a great advantage, especially in gynaecological laparotomies. The viscera are, as it were, congealed, are not stimulated by any fit of coughing or effort of vomiting, and therefore do not obstruct the field of operation, as happens so often with inhalation anaesthesia.

The occurrence of such phenomena as pallor of the face, nausea, or sweating, so often observed when spinal analgesia is produced by the injection of stovaine, tropacocaine, or novocain is seen only exceptionally when the stovaine and strychnine solution is used. The face retains its normal aspect; nausea occurs in 2.25 per cent.; vomiting—a single effortless ejection—in 1.25 per cent.; and sweating in 2 per cent. In some cachectic, feeble individuals I have observed faecal incontinence (4 per cent.). The pulse, which is slowed in spinal analgesia produced by stovaine alone, is, when the stovaine and strychnine solution is used, usually normal in rapidity and strength. Sometimes it rises to 80 or 90, but always remains strong. These facts prove the powerful influence of the strychnine

in neutralizing the depressing action of the stovaine. Under certain special conditions I have in 5 cases observed momentary stoppage of respiration; in 3 of these cases I had used for medico-cervical puncture a solution to which atropine $\frac{1}{3}$ mg. had been addded. I have abandoned both the use of atropine and puncture in this situation. In one other case I had used for high dorsal injection 4 cg. of stovaine, too large a dose, as subsequent experience has proved. In the fifth case dorso-lumbar puncture had been preceded by subcutaneous injection three and a half hours before operation of scopolamin and morphine. In this case, as I had feared in view of the poisonous effects of so powerful a drug as scopolamin, the respiration stopped, and was only re-established after fifteen minutes. None of these accidents can be attributed to the method that I have here described, but to departures from it which ought to be avoided.

DURATION OF ANALGESIA.

The analgesia, when the anaesthetic is administered in the manner described, lasts from one and a half to two hours, a period longer than is necessary to perform any operation. I should add for the benefit of surgeons inexperienced in spinal analgesia, that though the condition may be obtained with less than 3 cg. of stovaine in high dorsal puncture, and less than 10 cg. in the dorso-lumbar puncture, the anaesthesia is neither so deep nor so durable. With 8 cg. analgesia may be produced, but the patient preserves sensation of contact and of traction on the viscera, or on the sides of the wound. With 10 cg. all sensation is abolished; for this reason there should be no hesitation in using doses which may seem large, but which are harmless and produce complete anaesthesia. If an operation has lasted so long that the analgesia passes off, I make another puncture with the patient in dorsal decubitus, and in this way analgesia can be prolonged as long as may be necessary without inconvenience. The dose used for the second injection should be either equal to that given in the first or smaller, according to the probable duration of the operation.

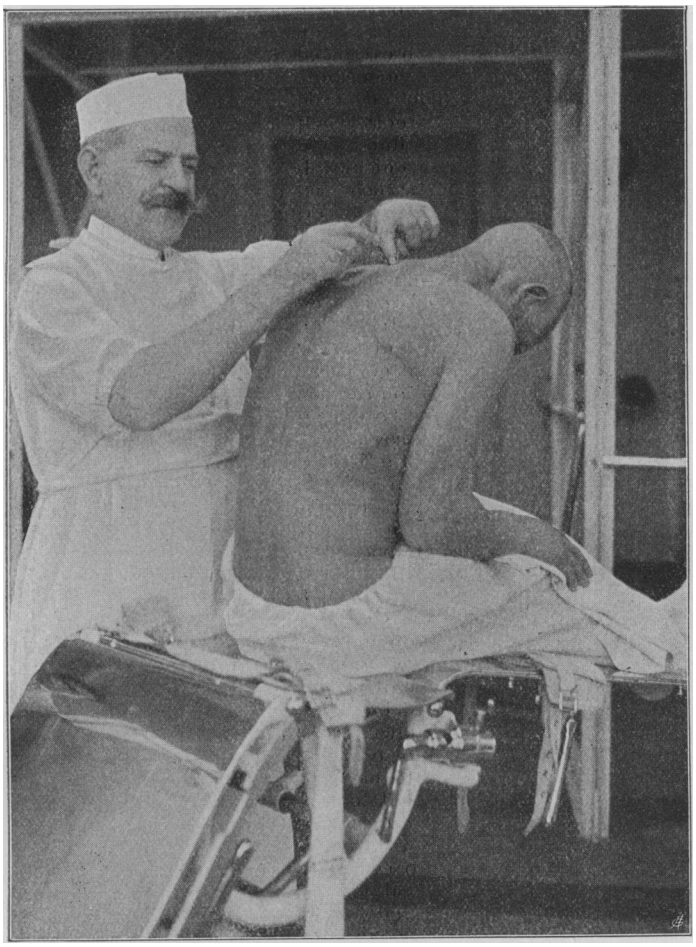

Fig 4.

PHENOMENA AFTER ANALGESIA.

Headache, retention of urine, and a rise of temperature, frequently observed when spinal analgesia is produced by stovaine alone, are seldom noted, and are of short duration when the method here described is followed. Headache has been observed in 6.25 per cent., but is not severe and disappears in a few hours. Transitory retention of urine was observed in 4.5 per cent., but only in those operations in which it is also produced with inhalation anaesthesia, such as those on the anus, the uterus, and for hernia. In no case did the temperature reach 40° C. (104° F.); a temperature as high as 39° C. (102.2° F.) was observed on the evening of the day of operation in 1.75 per cent.; of 38° C. (100.4° F) in 16 per cent.; of 37° C. (98.6° F) in 50 per cent. Post-operative vomiting has rarely been observed, and I have never seen post-analgesic paralysis.

STATISTICS.

The following are statistics of 398 operations performed by means of general spinal analgesia, from October 23rd, 1908, to July 5th, 1909.

I. HIGH DORSAL ANALGESIA, 103 CASES.

(*a*) *Operations on the Skull*, 14.—Decompressive herni-cranicctomies, for epilepsy (12); trephining of the mastoid process (1); angioma of the forehead (child 2 years old), extirpation (1).

(*b*) *Operations on the Face*, 45, including extirpation of epithelioma of the inferior lip, with extirpation of the submaxillary and submental glands (22); harelip, autoplasty, child, 3 years old (1); extirpation of a naevus of the labial commissure (1); cancer of the tongue, with extirpation of the submaxillary and submental glands (1); ectropion, autoplasty (5); ptosis of the superior eyelid, autoplasty (1); epithelioma of the inferior eyelid, autoplasty (1); paralysis of the left facial, myoplasty (1); sebaceous cyst of the orbit, extirpation (1); cancer of the orbit, enucleation (1); retro-ocular phlegmon, Kroenlein's operation (1); osteoma of the orbit, Kroenlein's operation (1); naso-pharyngeal polypes, Oliver's operation (5); resection of the superior maxilla (1); oste-operiostitis of the superior maxilla, trephining (1); osteo-sarcosis of the two submaxillary bones, resection (1).

(*c*) *Operations on the Throat*, 23. — Cervico-thoracic sympathectomy (11); resection of the superior cervical sympathetic ganglions (1); thyroidectomies (6); total laryngotomy for cancer (1); tracheotomy (1); external oesophagotomy for foreign body (set of teeth) (1); dorso-cervical lipoma, extirpation (1); cervical phlegmon, incision (1).

(*d*) *Operations on Thorax*, 7.—Cancer of the breast, large extirpation (Halsted-Balacesco-Legueu-Tiersch) (3); amputation of the breast with extirpation of the axillary gland (2); cystic disease of the breast, extirpation, and extirpation of the axillary glands (1); resection of ribs (1).

(*e*) *Operations on the Upper Limb*, 14.—Fracture of the clavicle, Lambotte suture (3); axillary adenitis, extirpation of the glands (2); axillary lipoma, extirpation (1); scapulo-humeral luxation (17 days), reduction (Kocher) (1); osteomyelitis of the humerus, trephining (1); enormous sarcoma of the arm, extirpation (1); ankylosis of the elbow, resection (1); autoplasty of the flexor tendons (1); section of the flexor tendons, tendinous sutures (1); tendinous dermoid cyst, extirpation (1); sanguineous redressment of the fingers and amputation of the thumb (1).

II. SPINAL DORSO-LUMBAR ANALGESIA, 295 CASES.

(*a*) *Laparotomies*, 52, including eventration (5); exploratory laparotomies (5); tuberculous peritonitis, laparotomy (2); Talma's operation (1); abdominal hydatid cyst, marsupialization (1); hydatid cyst of the liver, marsupialization (1); hydatid cyst of the liver, incision, extirpation, suture (5); cholecystectomies (4); splenectomies (8); gastro-enterostomies (5); resection of the pylorus, with gastro-enterostomy for ulcer (6); intestinal occlusion, laparotomy (2); appendectomies (6); iliac anus (1).

(*b*) *Gynaecologic Laparotomies with Inclined Plane*, 49, including hysterectomies (35); hysterectomies, with extirpation of the ilio-lumbo-pelvic ganglions for cancer of the uterus (5); retroflexion of the uterus, plications of the large ligaments, and intra-abdominal shortenings of the round ligaments (1);

atrophic ligatures for inextirpable cancer of the uterus (4); ovariectomies (3); extrauterine pregnancy (1).

(c) *Hernia, Radical Cure*, 70, including inguinal unilateral hernia (49); bilateral inguinal hernia (9); strangulated inguinal hernia (5); inguinal hernia with appendicitis (1); unilateral crural hernia (1); bilateral crural hernia (1); strangulated crural hernia (2); umbilical hernia (2).

(d) *Kidneys, Urinary Bladder*, 8.—Nephrectomy (1); nephropexies (3); hypogastric cystotomies (3); exstrophy of the urinary bladder (1).

(e) *Rectum and Anus*, 26.—Cancer of the rectum, abdomino-perineal extirpation (1); ano-rectal cancer, perineal extirpation (1); haemorrhoids, extirpation (Whitehead) (14); rectal stricture, extirpation (1); anal fissure, dilatation (2); anal stenosis, dilatation (1); rectal fistulae, cauterization (2); peri-anal vegetation, extirpation, cauterization (2); papilloma analis, extirpation (2).

(f) *Operations by the Vaginal Route*, 31.—Curettage of the uterus (20); vesico-vaginal fistulae (11).

(g) *External Genital Organs of Man*, 7.—Unilateral castration (2); radical cure of varicocele (4); radical cure of hydrocele (1).

(h) *Perineum*, 7.—Fistula and abscess, incision, curettage (6); perineorrhaphy (1).

(i) *Abdominal Coat*, 2.—Sarcoma, extirpation (2).

(j) *Lower Limbs*, 43.—Coxo-femoral luxations, reduction (4); coxo-tuberculosis, plaster apparatus (1); inguinal adenitis, extirpation (1); adenosarcosis, extirpation (3); fracture of the femur, Lambotte suture (1); myoma of the adductors, extirpation (1); varices, resection of the saphena (2); white tumour of the knee, arthrectomy and plaster apparatus (4); disarticulation of the knee (1); amputation, Sabanejeff (1); ankylosis of the knee, reduction (2); genu valgum, osteotomy (1); osteotomy of the leg bones (2); amputation of the leg (3); Lambotte suture of the tibia (3); extraction of pieces of metallic sutures (2); fractures of the leg bones, plaster apparatus (4); phlegmon of the leg, incision (1); transplantation of tendons, osseous resection for infantile paralysis (1); club-foot, Phelps's elongation of the tendo Achillis (4); incarnate malextraction (1).

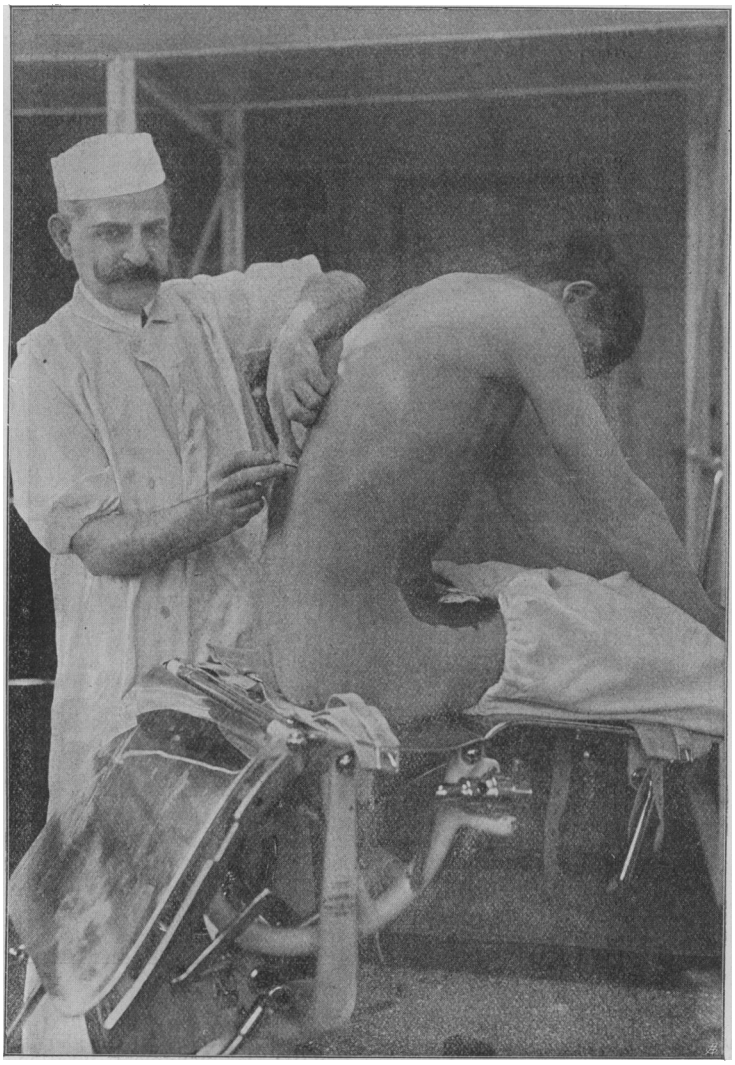

Fig. 5.

The ages of the patients have varied from children of 1 year 9 months to old people of 75 years. I have operated on 15 children under 10 years old, 1 of 1 year 9 months, 4 of 2 years, 1 of 3 years, 2 of four years, 1 of 5 years, 2 of 6 years, 2 of 8 years, 1 of 9 years, and 1 of 10 years. They all supported the injection perfectly with the doses I have above indicated. Therefore age is not a contraindication.

With regard to the general condition of the patient, chronic cardiac, pulmonary, renal, or hepatic diseases do not contraindicate the use of the method described. I have operated on persons with advanced cardiac diseases, such as myocarditis, aortic insufficiency, and mitral stenosis or insufficiency, without inconvenience; the same can be said as to other chronic affections. Further, acute or chronic infectious diseases are not contraindications, but the dose of the anaesthetic must be diminished. Neither angular nor lateral curvature interferes with success, save in exceptional cases of ossification of ligament. If to these 398 cases I add the statistics which I presented to the Congress at Brussels relating to 617 operations performed from July 6th, 1904, to July 25th, 1908, with lumbar, medio-cervical, or superior dorsal spinal analgesia (14 cases), I have a total of 1,015 spinal analgesias without a death, and without any serious complication either during analgesia or afterwards. Of earlier statistics, I need only recall that I have performed:

27 laparotomies (among them 2 splenectomies, 3 resection of the pylorus with gastro-enterostomy, 3 intestinal resections, 6 detortions of volvulus, 5 appendectomies, etc.); 24 gynaecologic laparotomies, with inclined plane (9 hysterectomies, 2 hysterectomies for cancer, with extirpation of the lumbo-ileo-pelvic ganglions, 12 atrophic ligatures for inoperable cancer of uterus). I have done also 14 first operations on the head, the neck, the thorax, and the upper limb, with medio-cervical or superior dorsal puncture (among them 1 temporary hemicraniectomy, 1 enucleation of the eye, 1 thyroidectomy, 2 resections of the cervico-thoracic sympathetic for exophthalmic goitre, 1 suture of the clavicle, 1 Halsted operation for cancer of the breast), etc.

Before concluding, I ought to add that two of my old pupils, now assistant surgeons to the hospitals—Drs. Jiano and Nasta—have been good enough to give me their statistics of operations under spinal analgesics produced by my method.

Dr. Jiano, operating in the first surgical clinic of the faculty (Senior Surgeon, Professor Severeano) at the Coltza Hospital, has had 114 cases, including 20 supero-dorsal or medio-cervical punctures (operations on the head, neck, thorax, and upper limb), and 94 dorso-lumbar punctures (operations on the abdomen, pelvis, perineum, and lower limb). Dr. Nasta, operating in the Dr. Racoviceano-Pitesti Clinic in the Colentina Hospital, reports the following: 19 dorso-superior and 78 dorso-lumbar punctures. In all these cases the results were excellent.

Deducting 603 lumbar analgesias with stovaine alone, I have 412 cases of analgesia with my new method—398 indicated in this paper and 14 published at Brussels—with 117 high injections, medio-cervical or supero-dorsal, and 295 low dorso-lumbar injections. Adding the cases of Drs. Nasta and Jiano, I have a total of 623 operations done by means of my method from July, 1908, to July, 1909, of which 156 with medio-cervical or supero-dorsal puncture—operations on the head, neck, thorax, upper limb—and 467 with dorso-lumbar puncture—operations on the abdomen, pelvis, perineum, lower limb, etc.

CONCLUSIONS.

1. The fundamental principles in spinal analgesia are that puncture of the arachnoid may be performed at all levels, and that to the anaesthetic, whether stovaine, tropacocaine, or novocain, strychnine should be added.

2. Puncture of the arachnoid at whatever level is harm-

less, and the fear of pricking the cord unfounded; even if it happens it is not harmful.

3. Medio-cervical puncture is useless and dangerous; mid-dorsal puncture is difficult and useless; superior dorsal puncture between the first and second dorsal vertebrae, and dorso-lumbar between the last dorsal and first lumbar vertebrae are easy, and suffice to obtain analgesia of all regions of the body.

4. The addition of neutral strychnine sulphate to the anaesthetic preserves the full antiseptic power of the solution and at the same time neutralizes its injurious action upon the bulb. Thanks to this addition, superior spinal analgesia can be performed without danger.

5. Among known anaesthetic substances, stovaine, tropacocaine, and novocain seem to be the best; any of them may be used with the addition of strychnine.

6. The strychnine and the anaesthetic substance need not be sterilized, a process which would destroy some of their properties.

7. The water used for making the solution must be sterilized but not distilled.

8. The injection should consist of 1 c.cm. of solution, the amount of strychnine and anaesthetic substance being varied.

9. The technique is simple, requiring only a Pravaz syringe and the usual needle for lumbar puncture.

10. There are no contraindications for general spinal anaesthesia, which always succeeds if the liquid penetrates into the arachnoid cavity and if the dose of the anaesthetic is sufficient.

11. General spinal anaesthesia is absolutely safe; it has never caused death, nor produced any important complications, early or late.

12. General spinal anaesthesia is infinitely superior to inhalation anaesthesia. Owing to its simplicity, it is within the reach of all, and as there is no contraindication it may be employed with any patient. As it can be performed by the surgeon himself it does away with the attendance of a person often inexperienced, and never responsible.

13. In operations on the face, or the throat, where analgesia by inhalation is difficult and often incomplete, spinal analgesia is a great resource. In laparotomies, owing to the "abdominal silence" it determines, it is very much superior to analgesia by inhalation.

14. The facts stated in this paper will prove how in science a condemnation *a priori* like that pronounced by Professors Bier and Rehn is precipitate and ill-founded.

15. I am firmly convinced that general spinal analgesia will be the analgesic method of the future.

REFERENCES.
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THE DEPARTMENTAL COMMITTEE ON HUMIDITY AND VENTILATION IN HUMID COTTON-WEAVING SHEDS.

BY COLONEL MATHEW D. O'CONNELL, M.D.

IN the Warrant of appointment of the Departmental Committee on Humidity and Ventilation in Cotton-Weaving Sheds, the Home Secretary asks the Committee to say: "At what degrees of heat and humidity combined definite bodily discomfort arises, under the conditions of the work carried on by the operatives, and what, if any, danger to health is involved by continuous work at those degrees."

Being for many years much interested in the question of the effect of combined heat and humidity in raising body temperature in warm and hot climates, I made some observations on a number of healthy men at rest, exposed within glass houses heated by 5-in. pipes, and, when it appeared, by the sun, and humidified by sprinkling the earthen floor with water at the natural temperature. The air within the glass houses was still. These houses are used for growing orchids, crotons, ferns, grapes, and tomatoes. The men during exposure wore their coats or not as they pleased. The body temperature was taken in the mouth. My object was not to ascertain how high body temperature can be raised by exposure to high degrees of atmospheric heat and humidity, for this is known; but to ascertain, if possible, the lowest degrees of atmospheric heat and humidity combined at which body temperature begins to rise above the maximum normal limit—37.2° C. (99.0° F.).

In each observation I give the dry-bulb temperature, the wet-bulb temperature, the absolute and the relative humidity of the atmosphere; for there seems to be some uncertainty as to which of these atmospheric factors is the cause of body temperature rising. So I think it better to give all. The observations are as follows: The drying power of the air is given per 10 cubic feet, as this is approximately the bulk of an average man.

From my own sensations in the glass houses and in warm and hot climates, I would say that bodily discomfort begins as soon as the body temperature begins to rise above the maximum normal limit, 37.2° C. (99.0° F.), from impediment to heat loss from the body. When body temperature begins to rise above this normal limit from increased production of heat in the body, as from exercise in the open air, I have not noticed the same discomfort until the body temperature reaches nearly 37.7° C. (100.0 F.). But in this paper I am not concerned with rise of body temperature from increased production of heat, but only from impediment to heat loss.

In order to apportion the relative importance of each meteorological factor of the atmosphere within the glass houses in producing rise of body temperature by impeding heat loss from the body, it is necessary to remember that heat is lost from the body by radiation, by evaporation, by conduction and convection, and by the excreta.

Loss of Heat from the Body by the Excreta.

As no excretions were voided during the short exposures in the glass houses, this need not be further referred to.

Loss of Heat from the Body by Radiation.

The rate at which any radiating body gives off heat depends on the difference between its own temperature and that of the surrounding air. When the dry-bulb temperature of the surrounding air is the same as the normal temperature of man—36.8° C. (98.4° F.)—no heat is being lost from the human body by radiation. As the dry-bulb temperature of the surrounding air falls below the temperature of the body, loss of heat from the body by radiation increases. When the dry-bulb temperature of the air falls to 0.0° C. (32.0° F.), or over sixty degrees below the temperature of the body, loss of heat from the body by radiation must be considerable.

Loss of Heat from the Body by Evaporation.

The rate at which heat is being lost from the body by evaporation depends on the drying power of the surrounding air, that is, its capacity for taking up water vapour. The drying power of cold air is small. At 0.0° C. (32.0° F.), air can contain only 21 grains of water vapour per 10 cubic feet when saturated. As at such temperature air is always nearly saturated, the amount of vapour it can take up is very little. Consequently loss of heat from the body by evaporation is little. Thus in air having a dry-bulb temperature of 0.0° C. (32.0° F.), when loss of heat from the body by radiation is considerable, loss of heat by evaporation is inconsiderable.

As the dry-bulb temperature of the air rises the drying power of the air increases, and as the dry-bulb temperature falls the drying power of the air falls. Whilst air having a dry-bulb temperature of 0.0° C. (32.0° F.) can only contain 21 grains of water vapour per 10 cubic feet, at 10.0° C. (50.0° F.) it can contain 41 grains; at 21.1° C. (70° F.) it can contain 80 grains; and at 36.8° C. (98.4 F.)—that is, at the temperature of the human body—it can contain 193 grains per 10 cubic feet. Hence as the dry-bulb temperature of the air rises, and loss of heat from the body by radiation decreases, the drying power of the air and loss of heat from the body by evaporation increase. In like manner, as the dry-bulb temperature of the air falls and loss of heat from the body by radiation increases, the drying power of the air and loss of heat by evaporation decrease. Thus it seems that loss of heat from the body by radiation and loss of heat from the body by evaporation are usually complementary one of the other; and for this reason exposure to great extremes of atmospheric temperature can be borne without abnormal increase or